Subproblem Method with h-Conform Formulation for Accurate Thin Shell Models Between Conducting Regions

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A subproblem method (SPM) with $\boldsymbol{h}$-formulation is developed for correcting the inaccuracies near edges and corners that arise from using thin shell (TS) models to replace thin volume regions by surfaces. The developed surface-to-volume correction problem is defined as a step of the multiple SPs and applied to a complete problem, with inductors and magnetic or conducting regions, some of the latter being thin. The treatment of the thin layers between conducting regions is considered.

The TS models (C. Geuzaine *et al*, "Dual formulations for the modeling of thin electromagnetic shells using edge elements," IEEE Trans. Magn., vol. 36, no. 4, pp. 799–802, 2000), assume that the fields in the thin regions are approximated by a *priori* 1-D analytical distributions along the shell thickness. Indeed, their interior is not meshed and extracted from the studied domain, which is reduced to a zero-thickness double layer with interface conditions (ICs) linked to 1-D analytical distributions that however neglect end and curvature effects. This leads to inaccuracies near edges and corners that increase with the thickness. To cope with these difficulties, the authors have recently proposed a SPM based on the $\boldsymbol{h}$-formulation for a thin region located between non-conducting regions (Vuong Q. Dang *et al*, "Subproblem Approach for Thin Shell Dual Finite Element Formulations", IEEE Trans. Magn., vol. 48, no. 2, pp. 407–410, 2012). The magnetic field $\boldsymbol{h}$ is herein defined by means of a magnetic scalar potential ϕ, i.e. $\boldsymbol{h} = -\text{grad}\,\phi$. This means that in an appropriate function space $F^1_{h\phi}(\Omega)$, the discontinuities of ϕ are considered on both sides of the TS, Γ^+_{ts} and Γ^-_{ts}, so that: i.e. $[\phi]_{\Gamma_{ts}} = \Delta\phi|_{\Gamma_{ts}} = \phi_{disc}|_{\Gamma_{ts}} = \phi_{disc}|_{\Gamma^+_{ts}} - \phi_{disc}|_{\Gamma^-_{ts}}$.

In this paper, the SPM is extended to account for the thin regions located between conducting regions. In these regions, $\Delta\phi|_{\Gamma_{ts}} = 0$ and the problem has to be expressed in terms of the discontinuities of $\boldsymbol{h}$ (i.e. $[\boldsymbol{h}]_{\Gamma_{ts}} = \Delta\boldsymbol{h}_{disc}|_{\Gamma_{ts}} = \boldsymbol{h}_{disc}|_{\Gamma_{ts}} = \boldsymbol{h}_{disc}|_{\Gamma^+_{ts}} - \boldsymbol{h}_{disc}|_{\Gamma^-_{ts}}$) to be strongly defined via an IC on both sides Γ_{ts}. The case of the thin regions between conducting and non-conducting regions can be studied as well. A reduced problem with only inductors is first solved on a simplified mesh without thin and conducting regions. Its solution gives surface sources (SSs) for a TS problem and conducting regions via ICs. The TS solution is further improved by a volume correction via SSs and volume sources, that overcomes the TS assumptions. Each SP has its own separate mesh. Details on the proposed method will be given in the full paper.